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U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
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ABSTRACT

Data on the Hawaiian monk seal, *Monachus schauinslandi*, were collected at Kure Atoll from 24 March to 6 October 1987. The mean count of 62 atoll-wide censuses of monk seals was 24.9, excluding pups of the year. Six pups, two males and four females, were born from late January to mid-May; one male and one female died before weaning. Five of the pups were born on the south side of Green Island; one was born on Sand Island. All surviving pups were double-flipper tagged after weaning; the weaned females were maintained in an ocean-beach enclosure until late August. One female pup was weaned early and, because of her small size, was brought to Honolulu for maintenance through the winter and was released at Kure Atoll in 1988. One of the mothers, at 6 years of age, was the youngest known-age monk seal to give birth. During the season, 391 samples of debris that could pose the threat of entanglement to seals were collected, accounting for more than 2,166 kg of net and line.

CONTENTS

INTRODUCTION

The islands of the Hawaiian Archipelago (Fig. 1), particularly the Northwestern Hawaiian Islands (NWHI), are used by the Hawaiian monk seal, *Monachus schauinslandi*, for hauling out to pup, nurse, molt, and rest, while the surrounding waters are used to mate and forage. Counts over the last 25-30 years (Johnson et al. 1982) revealed that the total monk seal population had been declining throughout the NWHI. Monk seals have been protected under chapter 187-4 of the Hawaii Revised Statutes and by the Marine Mammal Protection Act, and in November 1976, they were added to the endangered species list (Endangered Species Act of 1973). A monk seal research and recovery program was initiated in 1980 by the Southwest Fisheries Center Honolulu Laboratory of the National Marine Fisheries Service (NMFS), in an effort to determine the causes of the population decline and to enact a program to increase the population size (Gilmartin 1984).

At the northwestern end of the Hawaiian Archipelago lies Kure Atoll (lat. 28°25'N, long. 178°10'W; Fig. 2), the northernmost coral atoll in the world. It is composed of one permanent, vegetated island, Green Island, and two weather-dependent islets, Shark and Sand Islands. See Woodward (1972) for more information regarding the natural history of the atoll. Kure Atoll was designated a wildlife refuge in 1952 under jurisdiction of the Territory of Hawaii. In 1960, the building of a U.S. Coast Guard (USCG) loran station was begun, and the station was operable in 1961, housing 20 or more USCG personnel. It continues to operate at this level today.

The Kure population of monk seals has survived, despite human predation and disturbance at the atoll (Woodward 1972). However, since the late 1950's, the number of seals has decreased markedly (Johnson et al. 1982). In an effort to reduce the high pup mortality rate observed in the 1960's (Wirtz 1968) and 1970's (Johnson et al. 1982), temporary captive maintenance of female monk seal pups has been conducted annually since 1981 (Gilmartin et al. 1986). The goal of this work is to enhance the survival of young females in the Kure population. This program has been successful, as shown by the increasing number of juvenile and subadult seals at Kure Atoll (Gilmartin and Gerrodette[1]).

Monk seal research was conducted by NMFS at Kure Atoll in 1987. The main objectives were to monitor the Hawaiian monk seal population through beach counts, tag weaned pups, collect the weaned female pups for temporary captive maintenance, maintain yearlings from French Frigate Shoals until release, and quantify and sample debris capable of entangling seals. The results of this research are presented here.

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[1]Gilmartin, W. G., and T. Gerrodette. 1986. Hawaiian monk seal population status and recovery potential at Kure Atoll. Southwest Fish. Cent. Honolulu Lab., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96822-2396. Southwest Fish. Cent. Admin. Rep. H-86-16, 26 p.

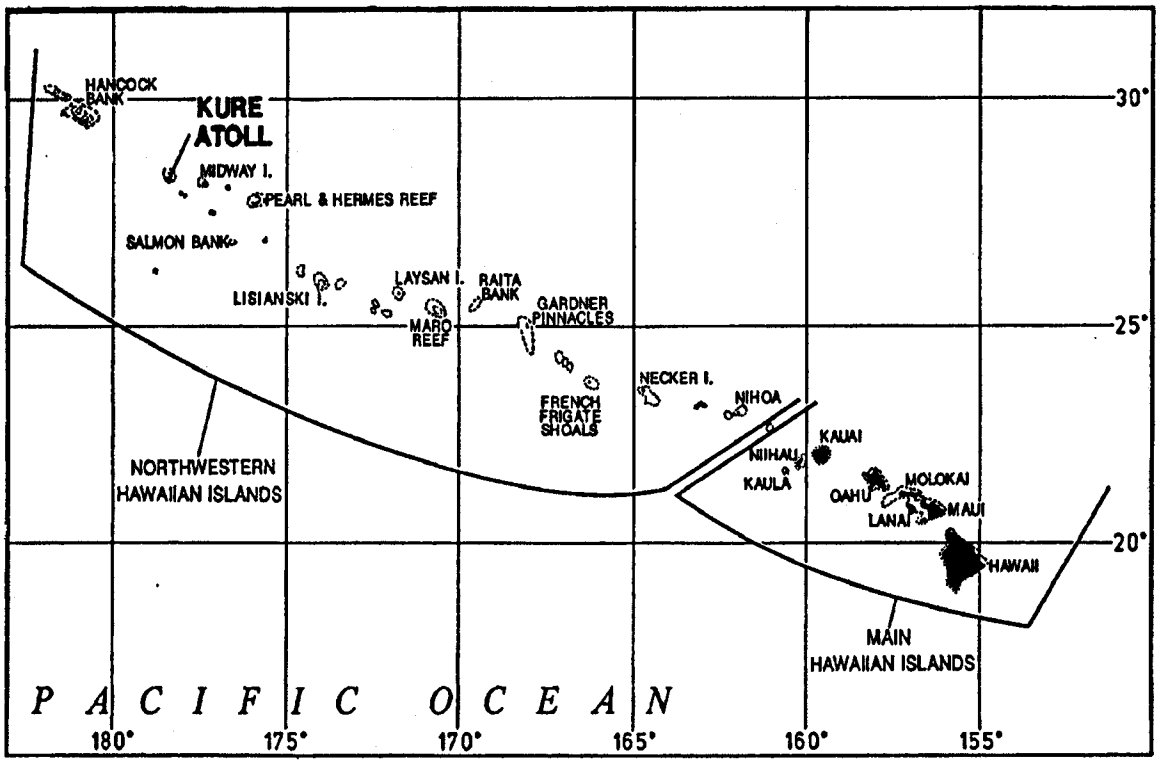

Figure 1.--The Hawaiian Islands.

METHODS

Census

Census data were collected at Kure Atoll by a single person, two-person tandem, or two-person split team from 27 March through 3 October. The two-person tandem censuses were conducted to ensure consistency in seal size classification when an observer was new to the atoll. Only two observers were present at the atoll at any time; a total of four observers collected census data. Censuses were usually conducted on an alternate day basis; however, on some occasions, duties related to pup maintenance or incoming USCG flights and volunteer personnel altered the schedule. When possible, the schedule was advanced by 1 day to ensure regular census counts. Appendix A outlines the field camp itinerary for Kure Atoll in 1987.

The beaches of all islands at Kure Atoll were divided into sectors (Fig. 2) for the purpose of recording specific seal haul-out locations. Green Island consisted of sectors 1-8 and sector 13, which was the ocean-beach enclosure for female pups, who were noted but excluded from census totals. Shark and Sand Islands were classified as sectors 9 and 10, respectively. Sector 11 was a shallow area in the lagoon known locally as Stark Reef, and any other haul-out site was sector 12 (i.e., exposed reef). Sectors were unequal in shoreline distance, unvegetated beach area, beach slope, and nearshore habitat. Sectors on Green Island are marked by permanent features, either natural or man made; therefore, sector divisions are consistent from year to year. Each beach was divided into categories: wet sand, dry sand, and permanent beach above the crest. The location, by sector and beach category, of each seal censused was noted. Not all sectors and beach categories were always present, especially on the islets where ocean conditions could result in major sand shifts, sometimes causing the islets to disappear. If that was the case, or if no seals were present, it was indicated as such in the data.

Because monk seals usually haul out in greater numbers in the afternoon (Kenyon and Rice 1959), censuses began at approximately 1300 (Hawaii standard time) at the junction of sectors 1 and 8, Green Island; however, the direction taken at this junction was varied. Split teams headed in opposite directions at this junction and met at the junction of sectors 3 and 4 or 4 and 5. The outer islands were censused after Green Island, weather permitting. The time required to complete a census varied with weather conditions, number of seals, and number of observers, all of which were indicated in the data. A standard census form and directions were employed (Appendixes B and C), and general census procedures are detailed by Stone (1984).

Seals were sexed if the ventrum was visible; classified by size; and identified, if possible, by scars, tags, or bleach marks (see Stone (1984) for detailed methodology). Weaned pups identified by tags were always classified as such. The molt status of each seal was recorded as percentage (1-100%) of total body area molted. If the seal's body position prevented the determination of molt status, it was noted on the census form. The only behavior and associations recorded were those occurring as the observer passed by the animals, because lengthy observations would prolong the census and possibly allow for a miscount due to seal movement. Any disturbances related to the observer also were recorded, as were associations between seals and debris capable of entanglement.

Tagging

All Kure pups were tagged after weaning; no other size classes of seals were tagged. The procedure and tag description are detailed in Gilmartin et al. (1986). Gray tags were used to indicate Kure Atoll as the seal's birth site. On each tag, an *N* indicating the seal was born in 1987 preceded a unique two-digit number. Data collected at the time of tagging included tag numbers, axillary girth, straight length of pup from nose to tip of tail, date and location of tagging, the identity of the mother, and the date of weaning. In addition, female pups were weighed by suspending the pup in a hoop net from a spring scale hung from a tripod. All lost or broken tags were replaced.

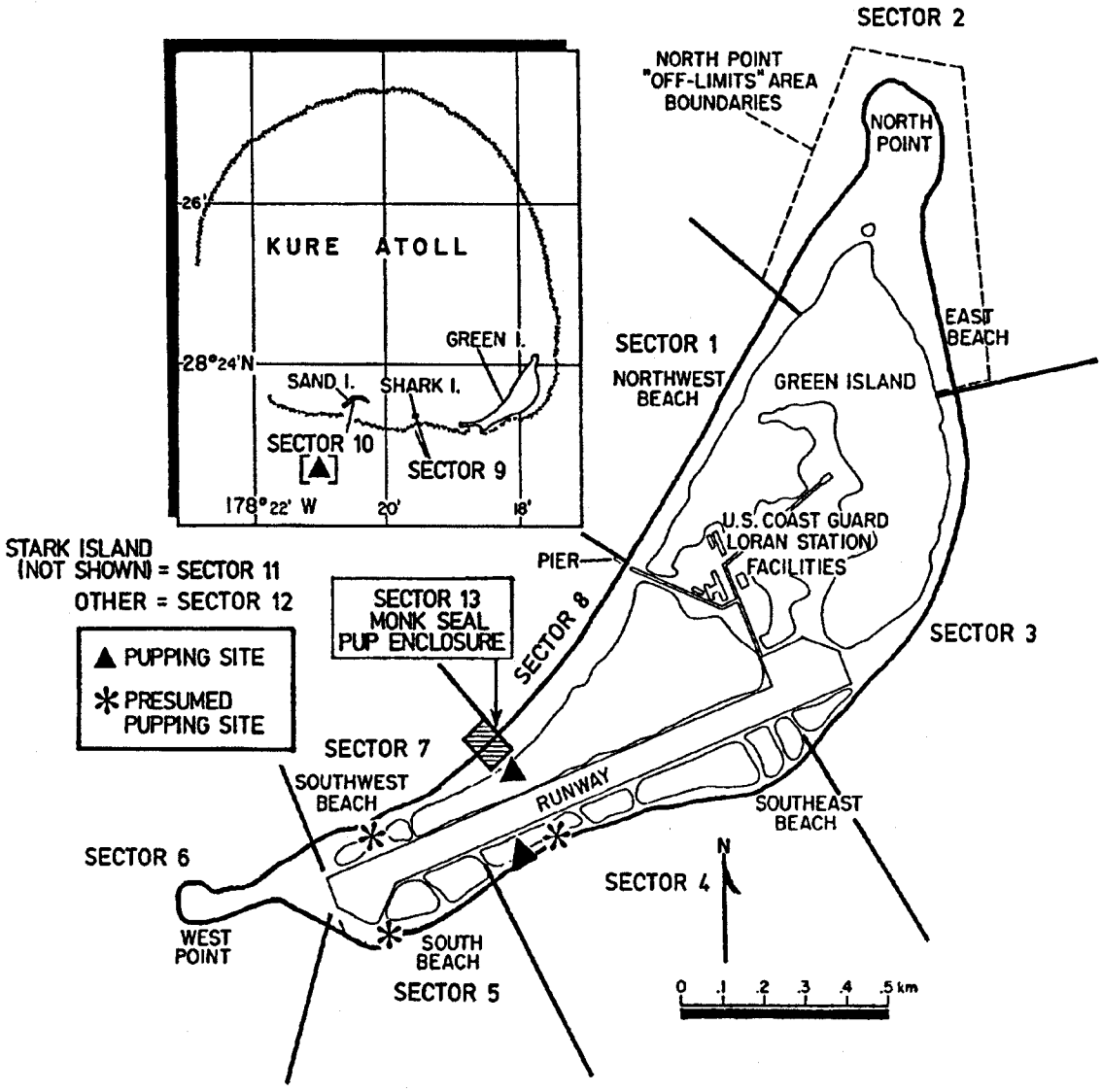

Figure 2.--Kure Atoll and Green Island, showing the Hawaiian monk seal enclosure site, off-limits area, sector divisions, and 1987 pupping sites.

Captive Maintenance Program

Newly weaned female pups, in addition to the tagging and weighing procedure, were placed in an ocean-beach enclosure (ca. 38 x 55 m) located on the southwest side of Green Island (Fig. 2). The enclosure included beach area as well as ocean and surrounded a large, natural coral head. Details on construction of the enclosure can be found in Gilmartin et al. (1986). Three female monk seal yearlings translocated from French Frigate Shoals also were placed in the enclosure and maintained from mid-April to late June (details of this work will be presented elsewhere).The condition of the enclosure was monitored regularly, and repairs were made when necessary.

To prepare the seals to forage independently in the wild, live fish and invertebrates were added to the enclosure at an average of 2.7 kg/day. These were caught in 10 wire mesh fish traps (ca. 65 x 65 x 90 cm), which were baited, placed at various sites near Green Island, and moved as necessary to obtain maximum yield. Species composition of the catch was similar to that reported in Gilmartin et al. (1986).

Collection of Specimens and Debris

Samples collected in 1987 included spews, necropsy samples, and debris capable of entangling wildlife. Spews were collected and frozen. The date and location found on the island were recorded. (Results of spew analysis will be presented elsewhere.) Dead seals were frozen and sent to Honolulu for necropsy. Debris capable of entangling wildlife was collected from the beaches, reef, and lagoon throughout the field season. A standard net inventory form and directions (Appendixes D and E) were employed. A sample was collected if it measured at least 1 m. Tangled masses were considered to be a single sample, even if they included different types of nets and lines; each different type of net or line was subsampled. Weights were estimated, and no distinction was made between dry and wet weights. Thick (> 90 mm diameter) mooring hawsers were excluded. Plastic rings and other debris that could encircle the head or flipper of a seal also were recorded and described. Sampled debris was transferred to a common collection site and eventually burned, in the absence of seals, turtles, and nesting seabirds and far enough away from the vegetation to avoid its destruction.

RESULTS AND DISCUSSION

Census Data

Counts

Sixty-two atoll-wide censuses were conducted at Kure Atoll from 29 March through 20 September 1987 (Appendix F); 29 additional censuses were conducted on Green Island only (Appendix G). The average number of seals in the atoll-wide censuses was 24.9, excluding pups of the year; 62% of the seals were found on Green Island, 26% on Sand Island, and 9% on Shark Island. (A small percentage was found on the reef.) The highest number counted

(not including pups) in a seal census was 47 on 11 April at Green Island (Appendix G); this count was the highest at Kure Atoll since the initiation of the monk seal recovery project in 1981 (NMFS data).

Oil-Tar

Oil-tar similar to that reported in 1976 (DeLong 1976) was found washed up on the beaches in 1987. The source of this substance is unknown. It was found adhered to the pelage of the seals and was useful in short-term identification.

Sector Use

North Point (sector 2) on Green Island was the most used sector, followed by Sand Island (sector 10) and Shark Island (sector 9) (Appendix H). These are the sectors that are off limits to USCG personnel. Birth sites for 1987 pups were sectors 4, 5, 7, and 10 (Fig. 2).

Tag Resightings

Kure Seals

Resightings of Kure pups tagged since 1981 are indicated in Table 1. Of the 16 females weaned at Kure Atoll since 1981 and included in the captive maintenance program, 15 were still alive at Kure Atoll in 1987. Although males have not been included in the captive maintenance program, 12 of the 17 males weaned at Kure Atoll since 1981 were still alive and present at the atoll in 1987. One additional male (ID No. KO26) born at Kure Atoll in 1981 was seen at Pearl and Hermes Reef in 1984 and 1985 (Morrow[2]) but has not been seen since.

Interatoll Movement

Interatoll movement has been described by Johnson and Johnson (1978), Johnson et al. (1981, 1982), Johnson and Kridler (1983), Johanos and Kam (1986), Johanos et al. (1987), and Johnson[3]. These reports usually involve atolls and islands other than Kure Atoll, where interatoll movement is rare. The following immigration cases are the first documented at Kure Atoll.

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[2]R. Morrow. Southwest Fisheries Center Honolulu Laboratory, National Marine Fisheries Service, NOAA, 2570 Dole St., Honolulu, HI 96822-2396, pers. commun. 1985.

[3]Johnson, A. M. 1979. A preliminary report of results of tagging-resighting data, Hawaiian monk seals. Report to Hawaiian Monk Seal Recovery Team, Natl. Mar. Fish. Serv., NOAA, Southwest Fisheries Center Honolulu Laboratory, 16 p.

Table 1.--Annual resightings of Hawaiian monk seal pups weaned and tagged at Kure Atoll, 1981-87 (M = male; F = female).

Year	No. of pups tagged		Resightings (No.) by year											
			1982		1983		1984		1985		1986		1987	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F
1981	4	5	4	4	4	4	3[a]	4	3[a]	4	2	4	3	4
1982	1	3			0	3	0	3	0	3	0	3	0	3
1983	4	0					3	0	3	0	3	0	3	0
1984	4	2							3	2	2	2	2	2
1985	2	3									2	3	2	3
1986	1	0											1	0
1987	1	3											1	3

[a]Excluded is one male (ID No. KO26) sighted at Pearl and Hermes Reef in 1984 and 1985 (text footnote 2).

Table 2.--Interatoll movement of Hawaiian monk seals at Kure Atoll, 1987.

ID No.	Tag No.	Size[a]	Sex[b]	Movement from	Movement to
				Date last seen	Date first seen
BL12	L12, L13	S	F	Pearl and Hermes Reef. 20 August 1986	Kure-Green Island. 23 June 1987
BK03	K03, K02	S	M	Pearl and Hermes Reef. 24 August 1986	Kure-Green Island. 10 September 1987
KO39	No tags	A	F	Pearl and Hermes Reef. 5 June 1986	Kure-Green Island. 26 March 1987
KO82	617, 618	A	F	Pearl and Hermes Reef. 23 August 1986	Kure-Sand Island. 17 May 1987
Y420	K37, K31	S	F	Kure-Green Island. 18 June 1986	Midway-Sand Island. 12 June 1987

[a]A = adult; S = subadult.
[b]F = female; M = male.

Five cases of interatoll movement were observed at Kure Atoll in 1987 (Table 2). Two involved Kure-born seals that were sighted at Kure Atoll during the 1985 field season, were subsequently sighted at Pearl and Hermes Reef in 1986, then resighted at Kure Atoll in 1987. Two other cases involved seals originally tagged at Pearl and Hermes Reef, which is located about 251 km southeast of Kure Atoll. The fifth case involved a seal born at French Frigate Shoals in 1985 and included in the translocation program at Kure Atoll in 1986; it subsequently moved to Sand Island, Midway.

Case 1. Female ID No. BL12, born and tagged at Pearl and Hermes Reef in 1986, was first resighted at Kure Atoll on 23 June 1987. She was resighted repeatedly throughout the remainder of the season.

Case 2. Male ID No. BK03, born and tagged at Pearl and Hermes Reef in 1985, was resighted there in 1986. He was first sighted at Kure Atoll on 10 September 1987, then resighted there repeatedly throughout the remainder of the season.

Cases 3 and 4. Two female seals ID No. KO39 and KO82 from the Kure population were seen at Pearl and Hermes Reef in 1986 (Forsyth et al. 1988). Both females were seen at Kure Atoll in 1985 (Reddy unpubl. data) and again in 1987. The only other documented round trip by a seal from the Kure population was in 1964-65 when Wirtz[4] reported that an adult male, tagged at Kure Atoll in October 1963 and last seen there in March 1964, was found on Lisianski Island, about 491 km to the southeast on 12 March 1965; by 27 March 1965, he had returned to Kure.

Case 5. Female ID No. Y420, born and tagged on French Frigate Shoals in 1985 and included in the translocation program at Kure Atoll in 1986, was not resighted at the atoll after release from the ocean-beach enclosure on 18 June 1986. She was resighted and photographed at Sand Island, Midway, on 12 June 1987 by military personnel.

The number of accounts of interatoll movement among Kure seals is increasing. As the number of tagged animals increases, the documentation of interatoll movement may increase as well.

Pup Production and Survival

Six pups were born at Kure Atoll from late January to mid-May (Table 3). Five of the pups were born at the south end of Green Island (Fig. 2), and one on Sand Island. Two of the pups born on Green Island died within 2 weeks after birth. Their bodies were recovered, frozen by USCG personnel, and flown to Honolulu for necropsy. One pup had been stillborn, the first stillbirth reported at Kure Atoll. Cause of death of the other pup was not determined because of the condition of its carcass (Table 4).

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[4]W. Wirtz, Dep. Zoology, Pomona College, Claremont, CA 91711, pers. commun. October 1989.

Table 3.--Summary of Hawaiian monk seal pups born at Kure Atoll, 1987 (U = unknown).

ID No. of pup	Tag No.[a] L	Tag No.[a] R	Sex[b]	Date Born	Date Weaned	Birth island	Days nursed	ID No. of mother	Date tagged	Measurement at tagging (cm) Girth	Measurement at tagging (cm) Length	Protective enclosure Date Capture	Protective enclosure Date Release	Total days in enclosure
KN84	N82[c]	N85	M	1/26	U	Green	U	K600	5/21	106	149	NA	NA	NA
KN97	N97	N96	F	2/19	3/31	Green	40	K601	4/15	120	136	4/15	8/25	163
--	--	--	F	ca. 3/5	Died	Green	U	U[d]						
--	--	--	M	ca. 3/19	Stillborn	Green	NA	U[d]						
KN88	N89	N86[e]	F	ca. 3/29	ca. 4/22	Sand	ca. 24	K050	4/23	96	116	4/23	5/12/88	--[f]
KN90	N90	N91	F	5/17	6/27	Green	41	K251	6/27	116	150	6/27	8/25	90

[a]L = Left hind flipper; R = right hind flipper.

[b]M = male; F = female.

[c]Originally tagged N84. This tag was lost and replaced with N82 on 6 June 1987.

[d]Adult female No. K083 was probably the mother of one of these pups (see text).

[e]Originally tagged N87 and N88. Tags N89 and N86 were exchanged for these tags on 21 March 1988 because they had become worn on the concrete tank in Honolulu.

[f]Flown to Honolulu on 25 August 1987. Returned to Kure Atoll on 22 March 1988, kept in captive maintenance ocean-beach enclosure for 52 days, and released on 12 May 1988.

Table 4.--Hawaiian monk seal deaths at Kure Atoll, 1987.

Field No.	Date	Size[a]	Sex[b]	ID	Cause of death
1	3/19[c]	N	M	--	Unknown
2	3/19[c]	N	F	--	Stillborn

[a]N = nursing pup.
[b]M = male; F = female.
[c]Date is approximate. Bodies were found and collected by U.S. Coast Guard personnel at Kure Atoll.

The pup (ID No. KN88) born on Sand Island was weaned after only about 24 days of nursing; its mother was not seen during the rest of the season. The pup was added to the ocean-beach enclosure on 23 April and, because of her small size, was fed about 1.8 kg of thawed herring each day to supplement her diet from 14 July to 25 August. She was usually fed twice a day, once at 0800 and again at 2000; at midday, she was also offered live reef fish, which she usually chased and caught but did not always eat. On 25 August, she was flown to the NMFS Kewalo Research Facility, where she was maintained throughout the winter because of her small size. She was returned to Kure Atoll in March 1988, held in the pen for about 7 weeks, and released in May.

Following the construction of the USCG loran station in 1960, the use of Green Island as a pupping site decreased while the use of the less stable sand islets increased. The use of the outer islets as pupping sites has been linked to human disturbance on Green Island (Kenyon 1972). The NMFS data collected at other monk seal pupping sites where human disturbance is not a factor reveal a preference for a certain type of habitat for pupping. This habitat includes a sandy, sloping beach, backed by vegetation and protected from shark intrusion by shallow, nearshore water or reef (Westlake and Gilmartin[5]). Green Island is the only island at Kure Atoll that has beaches conforming to this habitat. Restrictions on USCG personnel beach activities and educational efforts since the mid-1970's may be why all but two pups have been born on Green Island since 1982 (Table 5). The two pups were born on Sand Island, one in 1987. Kenyon (1972) suggested that, if the population of monk seals at Kure Atoll is to survive, it is probably necessary for Green Island to again be the primary pupping site. Enforcement of current restrictions is suggested to further reduce any disturbance and to maintain pupping on Green Island.

[5]Westlake, R. L., and W. G. Gilmartin. Hawaiian monk seal pupping habitat. Manuscr. in prep. Southwest Fish Cent. Honolulu Lab., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96822-2396.

Table 5.--Number and location of Hawaiian monk seals born at Kure Atoll, 1976-87.

Year	Total of pups born	No. of pups born by island		Reference
		Green Island	Sand Island	
1976[a]	9	4	5	Johnson et al.[b]
1977	10	4	6	Johnson et al.[b]
1978	10	4	6	Johnson et al.[b]
1979	10	3	7	Johnson et al.[b]
1980[c]	6-13	-	-	Johnson et al.[b]; Kenyon[d]
1981	10	6	4	Gilmartin et al. 1986
1982	5	5	0	Bowlby et al.[e]
1983	4	4	0	Bowlby et al.[e]
1984	6	5	1	Watson et al.[f]
1985	5	5	0	Reddy and Griffith 1988
1986	1	1	0	W. G. Gilmartin[g]
1987	6	5	1	This report

[a]Data provided by Commanding Officer Kichener, U.S. Coast Guard (USCG) loran station, Kure Atoll. This is likely a minimum count, as the USCG reported a total of 13 births to R. L. DeLong in 1976.

[b]Johnson, A. M., J. Ruehle, K. W. Kenyon, and M. Rauzon. 1982. Hawaiian monk seal studies: summary report, 1977-1980. Unpubl. rep. Denver Wildlife Research Center, Marine Mammal Section, 4454 Business Park Blvd., Anchorage, AK 99503, 76 p.

[c]A minimum of six weaned pups was observed by Kenyon (see table footnote d). The USCG reported 10 or possibly 12 births to him. Also, he observed weaned pups only, so the birth locations are less certain than in other years.

[d]Kenyon, K. W. 1980. Hawaiian monk seal observations at Kure Atoll, 17 June-3 July 1980. Unpubl. rep. National Fish and Wildlife laboratory, U.S. Fish and Wildlife Service, 11990 Lakeside Place NE, Seattle, WA 98125, 54 p.

[e]Bowlby, C. E., P. D. Scoggins, R. T. Watson, and M. L. Reddy. Hawaiian monk seal, Monachus schauinslandi, at Kure Atoll, 1982 and 1983. Manuscr. in prep. Southwest Fish. Cent. Honolulu Lab., Natl. Mar. Fish. Serv., NOAA, 2570 Dole St., Honolulu, HI 96822-2396.

[f]Watson, R. T., G. A. Peiterson, W. G. Gilmartin, and L. D. Consiglieri. Hawaiian monk seal population monitoring and pup captive maintenance program at Kure Atoll, 1984. Manuscr. in prep. Southwest Fish. Cent. Honolulu Lab., Natl. Mar. Fish. Serv., NOAA, 2570 Dole St., Honolulu, HI 96822-2396.

[g]W. G. Gilmartin. Southwest Fisheries Center Honolulu Laboratory, National Marine Fisheries Service, NOAA, 2570 Dole St., Honolulu, HI 96822-2396, pers. commun. October 1987.

Pup production at Kure Atoll is very low compared with 20-30 years ago (Kenyon and Rice 1959; Wirtz 1968). Pup survival since the 1960's and 1970's has increased, partly because of the captive maintenance program for female monk seals. Since 1981, 33 pups have been weaned successfully at Kure Atoll, and only 6 are missing or dead; of these 6, only 1 was female. When compared with the mortality reported by Wirtz (1968) in 1964-65, the success of the program is remarkably high.

Weaning was not observed; however, daily observations of mother-pup pairs allowed an error of less than 24 hours in weaning dates recorded (Table 3), except for one pup (ID No. KN88). Weather conditions prevented observers from visiting Sand Island near the weaning time of pup No. KN88. Data reported to date indicate an average nursing period of 40 days at Kure Atoll (Gilmartin et al. 1986; Reddy and Griffith 1988). Pup No. KN88 was weaned about 24 days after birth (Table 3).

Reproduction

The youngest known-age monk seal to give birth was documented in 1987 at Kure Atoll. At 6 years of age, this female (ID No. KO50) was one of the five females included in the captive maintenance program initiated in 1981. Previous to this birth, the only available data indicated that female monk seals became reproductively mature by at least age 7 (Johnson and Johnson 1978). The NMFS 1987 field season at Kure Atoll began after the birth of the first four pups (Table 3), two of which died (see section on pup production and survival) and their mothers were never identified. Necropsy reports suggested that the birth of the third pup was in late February, and the stillbirth of the fourth pup (Table 3) occurred during the first week of March (USCG personnel witnessed the stillbirth).

On 2 April, a large female seal was seen at the north end of Green Island. Tag numbers 890, 900, and 042 positively identified her as ID No. KO83, one of the female pups born in 1981 and included in the temporary captive maintenance program. Because of her extremely large size, protruding nipples, and swollen genital area, she was believed to be pregnant. She was never seen with a pup, but on 1 May, she was seen again, this time much smaller and 5% molted. Molt data collected throughout the NWHI to date have been studied, and some trends have been recognized. Monk seals molt once per year; if parturient during the year, female seals molt after giving birth. The time between the cessation of maternal investment (weaning or death of the pup) and the onset of molt averages 64 days (NMFS unpubl. data). The period between the deaths of the two pups and the onset of molt for female No. KO83 was 56-66 days. The evidence is not conclusive, but this female possibly was the mother of one of the dead pups. Several other adult females began molting within the same time frame, and although they could also be the mothers of the dead pups, none was noted as appearing pregnant earlier in the season.

Captive Pup Maintenance

All weaned female pups were successfully captured and placed in the ocean-beach enclosure on the southwest side of Green Island for captive maintenance. Data collected at the time of capture are presented in Table 3. (See Appendix I for an itinerary of Kure 1987 captive maintenance work.)

Reddy and Griffith (1988) reported that in 1985 the seals inside the enclosure had begun to associate the sound of the outboard engine with the delivery of their daily fish. It was recommended that a small adjoining holding pen be constructed to retain fish for transfer to the enclosure when the seals were asleep. This was attempted in 1987; however, the seals still associated the sound of the engine with the introduction of fish outside the fencing. For the remainder of the season, fish were motored to a site about 100 m away and carried by hand to the enclosure. Although this created an association between people and the arrival of fish, experience has shown that this association disappears soon after the seals are returned to the wild, unlike their outboard motor association, which apparently may last for years as demonstrated in 1987 by seals that had been released from the enclosure as long as 5 years previously. A better method for preventing any

associations from developing would be to build a holding pen at a minimum distance of 100 m from the enclosure and transfer fish when pups are asleep on the beach.

On 20 April, a storm and associated rough surf damaged the ocean-beach enclosure, allowing the escape of two yearlings (ID No. YL14 and YL16) from French Frigate Shoals and one pup (ID No. KN97). One yearling (ID No. YL14) and the pup were recaptured later that day. The missing yearling was located and returned to the enclosure on 23 April. During the time the yearling was out of the enclosure, she suffered a chest wound from a shark attack. For 4 days after her reintroduction to the enclosure, she avoided the water and was seen to lie on only her back on the beach. Antibiotic treatment was begun and continued for 1 week. Twice a day, 500 mg capsules of ampicillin were concealed in reef fish and fed to the yearling. By the end of the month, the yearling was active, her appetite was good, and the swelling and draining around the wound had greatly decreased.

On 21 April, a large subadult male seal climbed over the beach fencing and into the enclosure and was seen lying on the beach with the pup and yearlings. A portion of fencing was cut, and the male was chased out. Reinforcement wire and T-posts were added to the enclosure to prevent another break-in.

Male aggression outside the enclosure was observed, and males often congregated outside the fencing. After a pup (ID No. KN90) was born along the backside of the enclosure, male aggression became aimed at the nursing mother and pup. On many occasions, the mother was seen charging at the males, and in at least two instances, she came close to rolling on her pup. On the second day after the pup was born, the mother and two males were seen jousting. The fight moved into the water; the pup followed. The males were chased away by the mother; neither she nor the pup incurred any obvious injuries from the incident. Perhaps because of the nonspecific disturbance around the enclosure, the pup and its mother gradually moved south of the enclosure.

On 6 July, one pup (ID No. KN90) in the pen was observed with an abscess on her back. The cause of the abscess was unknown but suspected to be the result of a scratch from the fencing. The abscess opened on 7 July, and by the end of the month, the injury had almost completely healed. The enclosure was checked for sharp edges that could scratch the seals, and a few repairs were made to prevent further injury.

When the level of male aggression around the enclosure had decreased and the yearlings had begun to steal fish from the pups, the decision was made to release the yearlings. On 22 June, a hole was cut in the fencing of the enclosure, and two yearlings (ID No. YL16 and YL14) were released. The third yearling (ID No. YL15) was released 2 days later. One of the yearlings (ID No. YL14) was seen on 4 July with bite marks on her flank, so she was returned to the enclosure on 6 July because of concern for her safety. She was subsequently released on 13 July when she began stealing fish from the pups who were just beginning to learn how to catch them. Two of the yearlings (ID No. YL14 and YL15) were resighted for the remainder of the season; the third yearling (ID No. YL16) was last sighted on 1 July near Sand Island, where she was chewing on a decomposing octopus, and was not resighted again during the 1987 season.

Table 6.--Injuries of Hawaiian monk seals at Kure Atoll, 1987.

Field No.	Date	Size[a]	Sex[b]	No.	Injury	Probable cause
1	4/4	A	M	K034	Bleeding nose	Seal inflicted
2	4/22	S	F	YL16	Hole in chest	*Isistius brasiliensis*
3	5/31	A	M	K602	Lacerations on neck	Seal inflicted
4	5/31	A	F	K024	Hole in ventrum	*Isistius brasiliensis*
5	7/6	W	F	KN90	Abscess on back	Enclosure wire
6	7/7	S	F	K507	Abscess on back	Unknown
7	7/15	A	M	K014	Lacerated jaw	Seal inflicted

[a]W = weaned pup, S = subadult, and A = adult.
[b]F = female; M = male.

Rough lagoon conditions weakened the fencing of the enclosure, and the decision was made to release two of the pups (ID No. KN90 and KN97) on 25 August and to translocate the early weaned pup (ID No. KN88) to Honolulu for winter maintenance at the Kewalo Research Facility. The enclosure at Kure Atoll was immediately disassembled to prevent injury to seals. Pups KN90 and KN97 were resighted throughout the remainder of the season and appeared to be in good health.

Deaths and Injuries

The only known deaths were those of the pups (Table 4; see section on pup production and survival). Seven injuries were observed in 1987 (Table 6). Two were probably the result of an attack by the cookiecutter shark, *Isistius brasiliensis*, whose bite results in a circular wound (Jones 1971). Almost half of the observed injuries were probably the result of aggression between adult male seals. Fighting bouts were commonly observed throughout the season, and other displays of aggression such as vocalizations and chasing were common. In some cases, they involved not only adult male seals but also large subadults. Before the initiation of the monk seal recovery program at Kure Atoll, the subadult and juvenile segments of the population had become markedly small (Johnson et al. 1982). The success of the recovery

program at Kure Atoll has resulted in a growing subadult and juvenile population, with probable recruitment of several males to breeding age in the last 2 years. These males may be contesting the older hierarchy of male seals at the atoll. Observations of aggression between these two segments of the population during 1987 support this theory. Future research regarding this trend could provide interesting and valuable insight into the development of dominant animals and their effect on the population.

Collection of Materials

Only one spew was collected. It was frozen for analysis at a future date. Nets, lines, and other man-made debris have been shown to entangle Hawaiian monk seals (Balazs 1979; Henderson 1983; Stone 1984; Reddy and Griffith 1988). During the 1987 season, 391 samples of fishing debris that could entangle seals or other wildlife were collected and sampled at Kure Atoll. Accounting for over 2,166 kg of net and line, these samples will be analyzed for fishery of origin; the results will be presented elsewhere.

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APPENDIXES

Appendix A.--Field camp itinerary for Kure Atoll, 1987.

Date	Itinerary
3/24	D. Alcorn, B. Choy, and M. Reddy arrive to begin building the ocean-beach enclosure.
3/26	Alcorn and Choy depart, leaving Reddy to finish building enclosure and begin project work at the atoll.
4/14	*Discovery* (PBS) camera crew, T. Gerrodette, and L. Vaught arrive with the yearlings from French Frigate Shoals.
4/16	Gerrodette and film crew return to Honolulu. Vaught remains to assist with project work.
5/8	J. Flood replaces Vaught.
5/28	J. Kluss replaces Flood.
6/10	K. O'Brien replaces Kluss.
7/14	J. Miyashiro replaces O'Brien.
7/31	Miyashiro returns to Honolulu.
8/11	Alcorn and L. Hiruki replace Reddy.
8/25	Reddy and J. Lenox replace Alcorn and Hiruki. Pup (ID No. KN88) sent to Kewalo Research Facility, Honolulu.
8/25	Pups are released from enclosure; enclosure is dismantled.
9/9	Lenox returns to Honolulu.
10/6	Reddy returns to Honolulu.

Seal Census Form

PAGE _____ OF _____

ISLAND _____ OBSERVER ☐☐☐ TIME BEGIN ☐☐☐☐ END ☐☐☐☐

DATE _____ DATA TYPE ____ TEMP. ☐☐ WIND ☐☐☐

NUMBER _____ CLOUD ☐☐ PREC. ☐

LINE NO.	SECTOR	SIZE	SEX	ID NO.	ID ?	BLEACH	BLEACH ?	TAG NO.	TAG L/R	TAG COL	TAG ?	BEACH POS.	MOLT %	MOLT ?	DISTURB	TIME	A LINE NO.	A DIST.	A BEHAVIOR	B LINE NO.	B DIST.	B BEHAVIOR	CONTINUE	NOTES
1																								
2																								
3																								
4																								
5																								
6																								
7																								
8																								
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NOTES:

Form HL—118 Rev. 3—86

LINE NO.	SECTOR	SIZE	SEX	ID		BLEACH	TAG				BEACH POS.	MOLT		DISTURB	TIME	A			B			CONTINUE	NOTES
				NO.	?	?	NO.	L/R	COL	?		%	?			LINE NO.	DIST.	BEHAVIOR	LINE NO.	DIST.	BEHAVIOR		
18																							
19																							
20																							
21																							
22																							
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36																							

NOTES:

Appendix C.--Directions for completing the 1987 census form (Appendix B) to record all census and related data.

For more complete explanations of some items and definitions of such terms as census, sector, size, ID number, bleach number, and tag number, see the monk seal procedures manual (Gilmartin et al. in prep.).

ISLAND--Name of island and atoll, e.g., East Island, French Frigate Shoals.

OBSERVER--Three initials.

TIME--On a 24-hour clock; e.g., 6 p.m. = 1800.

DATA TYPE --C = census = a complete count on an island begun around 1300.
--A = atoll-wide census (usually completed during 1 day).
--P = patrol = any other observation not on a timed census.
Other letters may be used at the observer's discretion to indicate specific kinds of noncensus data, e.g., M for male observations.

NUMBER--Censuses and patrols assigned numbers at observer's discretion.

PAGE--If census (or patrol) requires three pages, then mark the first page as "Page 1 of 3" and so on. If two people census with separate sheets, then combine page numbers; person A has pages 1 and 2, while person B has pages 3 and 4 of a 4-page census day.

TEMP.--Temperature (°C) at beginning of census or patrol.

WIND--Speed: 0 = no wind, calm (< 5 kn)
1 = light breeze (5-15 kn)
2 = strong wind (> 15 kn)
Thus, 2 N N = strong wind from north

Direction: NW, NN, NE, EE, SW, SS, SE, WW

CLOUD--Cloud cover: 00 = no clouds
01-09 = 10 to 90% cover
10 = 100% cover

PREC.-- 0 = no precipitation
1 = mist/drizzle
2 = rain
3 = intermittent rain

SECTOR--Location on island (e.g., 1-49 on Lisianski Island; 99 = no island).

Appendix C.--Continued

SIZE--P1 = nursing pup, wrinkles
P2 = nursing pup, no wrinkles
P3 = nursing pup, blimp, black
P4 = nursing pup, molting
P5 = nursing pup, molted
→ P = nursing pup

PW = prematurely weaned (undersized) pup
W = weaned pup
J1 = juvenile I
J2 = juvenile II
→ J = juvenile

S3 = subadult III
S4 = subadult IV
→ S = subadult

→ I = immature

A = adult

T1 = turtle, juvenile (A cm)
T2 = turtle, subadult (65-80 cm)
T3 = turtle, adult (80 cm)
→ T = turtle

U = seal of unknown size

SEX-- M = Male
F = Female
U = Unknown

ID--Record ID number of seal if known; right justified: seal #25 = __25
? column: √ or 1 = ID number is questionable
0 = seal is definitely not an identified animal

BLEACH--Record bleach number of seal if known; right justified; these columns may also be used for any temporary numbers assigned in the field
? column: √ or 1 = bleach is present, but the number is questionable
0 = seal is definitely unmarked

TAG--Tag number if known; right justified: tag #K23 = _____K23
L/R: tag position--L = tag on left flipper
R = tag on right flipper
B = tags on both flippers (only one tag number need be entered)
COL:color code--G = green (Lisi) T = tan (Laysan)
K = gray (Kure) R = red (Midway,Necker,Nihoa)
B = Blue (P & H) Y = yellow (FFS)
M = metal
? column: √ or 1 = seal is tagged, but the number is questionable
0 = seal is definitely not tagged

BEACH POS.--Location of seal or turtle when observer comes abreast of animal (i.e., seal may be seen midbeach from a distance and yet be at waterline when observer comes abreast; seal would be recorded as at waterline).

Appendix C.--Continued.

0 = animal in water or on an offshore rock (not included in census tally but may be used for behavioral data)
1 = along waterline, on wet sand
2 = midbeach, on dry sand
3 = vegetation zone or beach crest, on permanent beach

MOLT--Percentage of old pelage lost; optional for nursing pups
blank or 0 = no molting evident
__1-__99 = 1 to 99% molted (right justified)
____100 = 100% molted, freshly molted, up to 1 month after molt
? column: √ or 1 = % molt estimate is questionable

DISTURB--The degree to which the seal may have been disturbed by observer:
blank or 0 = no disturbance, or seal merely looked at observer
1 = seal vocalized, gestured, or moved <2 body lengths
2 = seal alerted to observer and moved >2 body lengths
3 = seal alerted to observer and fled into water

TIME--The time of an observation, on a 24-hour clock.

ASSOCIATION DATA--There's room to describe two different associations (A and B).
Active associations
1) noted for all except behaviors between mother and nursing pup
2) must take place within 30 m of observer
3) subjects may be any distance apart

Spatial associations
1) noted as observer comes abreast of the subject
2) entangleable object: distances <2 m away
3) individual seals and turtles
- mother-pup pair (*N*): any distance
- all others (*L*): distances <10 m away; record two nearest neighbors in straight line of sight
- record seal-seal and turtle-seal associations but not turtle-turtle associations.

LINE NO.--Identity of the other party in the association
1) if a seal or turtle's line No. is recorded here
(note line No. refers to within same census page only)
2) if an entangleable object, put
NR or 99 = net and/or rope or
FL or 98 = flotsam other than above

DIST.--Closest distance during behavior
0 = body contact
1 = <2 m

Appendix C.--Continued.

2 = 2-5 m
3 = >5 m (>5 m but <10 m in the case of L behavior code)

BEHAVIOR--Up to four behaviors may be recorded for each association, but *N, E, X,* and *O* should not appear together with other behaviors

1) individual seal or turtle

a) active behavior

A = approach/investigate/sniff/nudge	
B = bite, nip	B = bite
B2 = bite, draws blood/breaks skin	
C1 = chase, <2 body lengths*	C = chase*
C2 = chase, >2 body lengths*	
D = displace*	
F1 = flee/move away, <2 body lengths	F = flee/move away
F2 = flee/move away, >2 body lengths	
J1 = joust <30 seconds*	J = joust/spar/fight*
J2 = joust >30 seconds*	
M1 = mount/attempted mount <30 sec	M = mount/attempted
M2 = mount/attempted mount >30 sec	
P = play*	
R = roll/present ventral	
V = vocalize	

*Requires a corresponding code on the line of the associated seal.

Example of an active association:

b) Spatial association

N = mother-pup pair (any distance)
L = association by location only (distance <10 m apart, for all except mother-pup pairs)

2) entangleable object

L = association by location only (distance <2 m)
E = subject is entangled

3) nothing nearby

O = no behavior or association

4) no data

X = no association data on census

CONTINUE--If the same animal is recorded on another line for any reason (e.g., additional tag or association, behavior at a later time, or change of beach position), put the line number you're continuing *from* here. Lines may be continued only within the same page.

NOTES-- √ or 1, if you have handwritten notes on the observation. Put hand-written notes on the back of the census form, labeled by line No.

L = observation is purely incidental, i.e., not on census/patrol
R = seal is on rock offshore (combined with beach position 0)

Appendix C.--Continued.

Additional notes:

1. Weather information (except temperature) should be a summary of the entire day up until the end of the census, not merely an instantaneous observation.

2. A separate data sheet should be filled out for each date, observer, data type, and island within an atoll. If no seals are present, you should still fill out the information at the top of the census form and write "No seals" in the data area. If the island itself is not present, indicate this by using 99 for the sector code, leaving the rest of the (first) line blank.

3. All associations (except with entangleable objects) should be in pairs, i.e., between animals on two different lines. If the behavior is active, you should fill in the line numbers, distances, and behavior codes for both animals involved in the association. If the behavior is *N* or *L*, however, you may record the association on only one of the lines, leaving it to the computer to fill in the other line.

4. An association should either be all blank or have the *O* or *X* behavior only, with no line number or distance, or have a line number, a distance, and a behavior code (other than *O* or *X*) all present.

5. On a census, it is assumed that molt, disturbance, and behavioral data will be taken. Thus, on a census data sheet, no code in any of the A or B columns means that the seal was alone, while on a patrol data sheet, this may simply mean that no data were taken. It is not necessary to put an O code for each unassociated animal on census. The computer will fill this code in later. If you are unable to record association data on a census for any reason, indicate this with an *X* for the behavior code.

6. Record all tag sightings explicitly (i.e., both left and right tag numbers) at least once during your stay. When a pup is tagged, record the first occurrence of that tag on a census data sheet for that date as well as on a tagging card. If a seal is identified via a tag, it is not necessary to look up and enter its ID number as well as tag number on the census form. ID number will be added by computer later.

Appendix D.

Net and Line Samples

PAGE NUMBER _____ OF _____ PAGES

FROM _____ (ISLAND) FROM _____ (DATES) TO _____

SAMPLE NUMBER	COLLECTOR INITIALS	DATE COLLECTED	DATE ASHORE	LOCATION: SECTOR AND/OR ISLAND	MATERIAL	COLOR	TOTAL SIZE: L/W/H OF ORIGINAL (METRIC)	WEIGHT: (INDICATE IF LB. OR KG.)	NET SAMPLE TYPE*	STRETCHED MESH (CM)	TWINE DIAMETER (MM)	COMMENTS

Appendix E.--Directions for completing net inventory form (Appendix D) for 1987.

I. Materials to catalog.

A. All scraps of webbing (fishing net).

B. All fragments, scraps, and piles of line that are considered to be hazardous to wildlife:

1. Lines with loops large enough to encircle a turtle's flipper or head or a seal's head should be included.

2. Short (< 1 m) fragments of line with no loops should be excluded.

3. Thick (90 mm diameter or larger) mooring hawsers should be excluded.

C. Plastic straps or bands--note if cut or loop.

D. Plastic rings or loops (identify, measure inner diameter, and describe).

II. Materials not to be cataloged.

A. Fishing floats (unless attached to webbing).

B. Glass or plastic balls with rope webbing around them.

C. Other plastic items, unless an entanglement in such is observed; in which case, the item should be collected if possible.

III. Sampling and cataloging procedures.

A. General: Materials should be assigned a number, measured, and logged on the data sheet. Assign a net "type" according to the net sample kit sent into the field. The sample pile should be flagged to avoid counting it more than once. If materials are partially buried, the portion that is above the ground should be measured. Check for bones, especially in large tangles of webbing.

B. Numbering: Debris samples should be numbered according to the following format: ISLAND (three letters), YEAR (two numbers, i.e., 87), SEQUENTIAL NUMBER (up to five digits, including decimal place). Thus, KUR8704 would denote the fourth sample collected from Kure Atoll in 1987. Decimal notation should be used to denote subsamples of a tangle of nets and lines. Thus, if the twelfth sample collected at Kure were a tangle of various nets, nets in the mass would be labeled KUR8712.1, KUR8712.2, and so on.

Appendix E.--Continued.

C. Measuring: Do not untangle piles of webbing or line. Instead, measure (in meters) the length, width, and height of the pile. For webbing, measure the stretched mesh size by stretching a mesh to its longest point (i.e., pulling on opposite knots, "closing" the mesh) and measuring (in centimeters) between the inner edges of the opposite knot. Also, measure the thickness (diameter) of the twine. If a pile includes many types of webbing or line, estimate in the comments section of the data sheet the percentage, by size, of each type.

D. Cataloging: No samples will be collected; however, a "net sample kit" has been sent to each island. As best as possible, match the webbing of the debris to one of the types, first for mesh size, then twine diameter. Estimate the weight (in pounds or kilograms) of the entire debris item. Note the color and type of the webbing or line material, using P = poly (polypropylene or polyethylene), M = monofilament or nylon, C = cotton, and H = hemp or other natural fiber.

E. Disposal: Move debris items to one or two collecting locations and burn them, making sure to keep well away from seals, turtles, birds, and plants.

Appendix F.--Summary of census counts of Hawaiian monk seals, by size and sex, at Kure Atoll, 1987. Whole-atoll counts only (M = male, F = female, and U = unknown).

	Adult			Subadult			Juvenile			Pup			Total		
Date	M	F	U	M	F	U	M	F	U	M	F	U	Non-pup	Pup	Grand
3/29	7	3	2	3	3	5	0	0	0	0	1	0	23	1	24
4/2	8	6	6	7	4	0	0	0	0	1	1	0	31	2	33
4/4	9	4	3	7	5	5	0	0	2	1	1	0	35	2	37
4/8	13	8	3	7	8	3	1	0	1	1	1	0	44	2	46
4/27	7	2	7	5	7	6	0	3	0	1	2	0	37	3	40
4/29	6	2	9	3	4	5	0	2	0	1	2	0	31	3	34
5/1	5	3	2	4	3	6	0	3	0	1	2	0	26	3	29
5/3	9	4	2	2	2	7	0	3	0	1	2	0	29	3	32
5/5	8	1	5	7	6	2	0	3	0	1	1	0	32	2	34
5/11	8	2	7	1	5	8	0	3	0	1	1	0	34	2	36
5/13	3	3	7	2	5	5	0	1	0	1	1	0	26	2	28
5/15	8	3	3	8	4	6	0	3	0	0	2	0	35	2	37
5/17	7	6	1	7	4	5	0	0	3	0	1	2	33	3	36
5/21	9	3	3	2	3	4	0	3	0	0	3	1	27	4	31
5/23	8	4	0	4	2	3	0	1	0	0	0	1	22	1	23
5/25	9	4	1	5	3	1	0	2	0	0	2	0	25	2	27
5/27	4	6	6	4	1	4	0	3	0	0	2	0	28	2	30
5/29	7	3	1	4	3	6	0	1	1	0	2	1	26	3	29
5/31	9	3	4	6	5	2	0	2	1	1	0	1	32	2	34
6/6	7	5	1	8	6	1	0	0	0	1	3	0	28	4	32
6/8	7	2	3	2	3	4	0	0	0	0	2	1	21	3	24
6/11	3	3	7	10	5	3	0	0	0	0	3	0	31	3	34
6/13	7	2	3	5	4	6	0	2	2	0	3	0	31	3	34
6/15	11	2	2	6	3	3	0	2	0	0	3	0	29	3	32
6/17	6	1	4	4	1	2	0	0	0	0	3	0	18	3	21
6/19	8	2	0	4	1	1	0	0	0	0	3	0	16	3	19
6/21	6	2	3	1	2	3	0	1	0	0	1	0	18	1	19
6/25	3	2	2	3	5	5	0	1	0	0	3	0	21	3	24
6/29	6	0	1	6	2	3	0	2	0	0	3	0	20	3	23
7/1	8	1	0	6	4	4	0	1	0	0	2	0	24	2	26
7/3	3	1	3	2	4	2	0	2	0	0	2	0	17	2	19
7/5	3	1	1	2	4	0	0	1	0	0	2	0	12	2	14
7/7	6	2	2	2	1	3	0	1	0	0	2	0	17	2	19
7/9	3	0	1	3	2	2	0	0	0	0	3	0	11	3	14
7/11	5	0	4	4	1	1	0	0	0	0	0	0	15	0	15
7/13	8	1	0	8	4	0	0	0	0	0	3	0	21	3	24
7/19	3	1	0	8	4	3	0	2	0	0	3	0	21	3	24
7/21	6	1	1	3	3	2	0	0	0	0	2	0	16	2	18

Appendix F.--Continued.

Date	Adult			Subadult			Juvenile			Pup			Total		
	M	F	U	M	F	U	M	F	U	M	F	U	Non-pup	Pup	Grand
7/23	3	0	2	5	2	4	0	0	0	1	3	0	16	4	20
7/25	6	1	1	2	3	5	0	2	0	1	0	0	20	1	21
7/27	3	1	0	3	3	8	0	0	0	1	0	0	18	1	19
7/29	3	0	3	4	4	2	0	1	0	0	2	0	17	2	19
8/1	1	1	2	1	1	5	0	1	1	0	1	0	13	1	14
8/7	6	0	3	5	4	1	0	2	0	0	2	0	21	2	23
8/9	2	2	2	4	1	4	0	2	0	0	2	0	17	2	19
8/12	5	1	4	3	2	0	0	0	0	0	2	0	15	2	17
8/14	9	3	2	9	2	0	0	1	0	0	3	0	26	3	29
8/16	9	2	1	5	5	3	0	2	0	0	2	0	27	2	29
8/18	8	2	2	5	1	2	0	1	0	0	1	0	21	1	22
8/20	13	1	2	1	2	2	0	0	0	0	2	0	21	2	23
8/22	6	1	5	1	1	1	0	1	1	0	3	1	17	4	21
8/28	7	2	4	7	3	0	0	1	0	0	1	0	24	1	25
8/30	11	2	5	4	1	4	0	2	0	0	0	0	29	0	29
9/1	7	3	5	7	3	5	0	1	0	0	1	0	31	1	32
9/3	5	0	5	3	4	5	0	1	0	0	0	0	23	0	23
9/5	5	1	6	8	4	6	0	1	0	0	1	0	31	1	32
9/10	5	4	5	8	4	3	0	1	0	0	1	0	30	1	31
9/12	12	3	3	6	1	2	0	2	0	0	1	0	29	1	30
9/14	4	2	7	7	4	8	0	1	0	1	0	0	33	1	34
9/16	8	4	4	12	6	4	0	2	0	0	0	0	40	0	40
9/18	7	0	5	3	2	12	0	1	0	0	1	0	30	1	31
9/20	7	1	6	10	6	3	0	1	0	1	1	0	34	2	36

Appendix G.--Summary of census counts of Hawaiian monk seals, by size and sex, at Green Island, Kure Atoll, 1987 (M = male, F = female, and U = unknown).

	Adult			Subadult			Juvenile			Pup			Total		
Date	M	F	U	M	F	U	M	F	U	M	F	U	Non-pup	Pup	Grand
3/27	6	6	1	1	1	2	0	0	0	0	1	1	17	2	19
3/29	3	2	1	2	3	2	0	0	0	0	0	0	13	0	13
3/31	7	3	1	1	2	0	0	0	0	0	0	2	14	2	16
4/2	4	2	2	3	3	0	0	0	0	1	0	0	14	1	15
4/4	6	2	2	3	3	5	0	0	2	1	0	0	23	1	24
4/6	7	3	1	4	5	5	0	1	1	1	0	0	27	1	28
4/8	11	6	0	5	6	2	1	0	1	1	0	0	32	1	33
4/11	12	9	3	8	4	9	0	0	2	1	1	0	47	2	49
4/21	8	2	3	5	6	4	0	2	0	1	1	0	30	2	32
4/23	5	4	3	3	8	3	0	0	0	1	1	0	26	2	28
4/25	5	3	6	2	5	4	0	3	0	1	2	0	28	3	31
4/27	7	2	4	4	5	6	0	3	0	1	2	0	31	3	34
4/29	6	2	5	3	4	4	0	2	0	1	2	0	26	3	29
5/1	4	3	1	4	3	4	0	3	0	1	2	0	22	3	25
5/3	8	4	2	1	2	6	0	3	0	1	2	0	26	3	29
5/5	5	1	3	5	5	2	0	3	0	1	1	0	24	2	26
5/7	10	3	4	6	3	1	0	2	0	0	2	0	29	2	31
5/9	4	2	5	2	2	7	0	0	0	0	1	0	22	1	23
5/11	5	2	6	0	3	7	0	3	0	1	1	0	26	2	28
5/13	1	3	4	2	5	4	0	1	0	1	1	0	20	2	22
5/15	6	1	1	6	4	3	0	3	0	0	2	0	24	2	26
5/17	4	4	0	7	4	3	0	0	3	0	1	2	25	3	28
5/19	5	1	4	6	4	2	0	3	0	0	3	0	25	3	28
5/21	5	3	3	0	2	1	0	3	0	0	3	1	17	4	21
5/23	5	3	0	4	2	2	0	1	0	0	0	1	17	1	18
5/25	7	3	1	3	2	1	0	2	0	0	2	0	19	2	21
5/27	1	4	5	3	1	3	0	3	0	0	2	0	20	2	22
5/29	6	3	1	4	3	2	0	1	1	0	2	1	21	3	24
5/31	8	3	1	3	4	2	0	2	1	1	0	1	24	2	26
6/2	5	3	1	2	4	0	0	2	0	0	3	0	17	3	20
6/4	7	1	1	2	5	1	0	0	0	0	2	0	17	2	19
6/6	3	5	0	6	4	0	0	0	0	1	3	0	18	4	22
6/8	6	2	0	2	3	1	0	0	0	0	2	1	14	3	17
6/10	5	2	1	4	4	2	0	2	1	0	2	0	21	2	23
6/11	3	3	6	5	4	2	0	0	0	0	3	0	23	3	26
6/13	6	2	3	4	3	4	0	2	2	0	3	0	26	3	29
6/15	9	2	2	5	2	1	0	2	0	0	3	0	23	3	26
6/17	4	1	3	0	1	2	0	0	0	0	3	0	11	3	14
6/19	5	2	0	4	0	1	0	0	0	0	3	0	12	3	15
6/21	3	1	3	0	1	3	0	1	0	0	1	0	12	1	13
6/23	3	2	5	1	2	5	0	2	0	0	0	0	20	0	20

Appendix G.--Continued.

Date	Adult			Subadult			Juvenile			Pup			Total		
	M	F	U	M	F	U	M	F	U	M	F	U	Non-pup	Pup	Grand
6/25	2	1	1	2	2	3	0	1	0	0	3	0	12	3	15
6/27	5	0	4	4	1	1	0	1	0	0	3	0	16	3	19
6/29	4	0	1	3	1	2	0	1	0	0	3	0	12	3	15
7/1	3	0	0	5	1	4	0	1	0	0	2	0	14	2	16
7/3	2	0	2	2	1	2	0	2	0	0	2	0	11	2	13
7/5	1	0	0	2	0	0	0	1	0	0	2	0	4	2	6
7/7	5	1	0	1	0	1	0	1	0	0	2	0	9	2	11
7/9	0	0	0	2	1	1	0	0	0	0	3	0	4	3	7
7/11	3	0	1	3	0	0	0	0	0	0	0	0	7	0	7
7/13	4	0	0	6	1	0	0	0	0	0	3	0	11	3	14
7/15	3	0	2	3	1	2	0	0	0	0	2	0	11	2	13
7/17	2	2	2	6	2	4	0	1	0	0	3	0	19	3	22
7/19	0	0	0	2	3	3	0	1	0	0	3	0	9	3	12
7/21	6	1	1	1	1	1	0	0	0	0	2	0	11	2	13
7/23	2	0	2	3	1	2	0	0	0	0	3	0	10	3	13
7/25	4	0	0	2	0	4	0	2	0	0	0	0	12	0	12
7/27	1	0	0	3	3	7	0	0	0	0	0	0	14	0	14
7/29	1	0	0	2	0	1	0	0	0	0	2	0	4	2	6
8/1	0	0	2	1	1	3	0	1	0	0	1	0	8	1	9
8/3	3	0	3	2	1	1	0	2	1	0	1	0	13	1	14
8/5	1	0	2	3	3	1	0	1	0	0	2	0	11	2	13
8/7	1	0	0	1	1	0	0	1	0	0	2	0	4	2	6
8/9	2	1	2	0	0	4	0	1	0	0	2	0	10	2	12
8/12	4	1	1	3	0	0	0	0	0	0	2	0	9	2	11
8/14	6	2	0	4	0	0	0	0	0	0	3	0	12	3	15
8/16	5	0	1	4	3	2	0	2	0	0	2	0	17	2	19
8/18	1	0	0	3	0	1	0	1	0	0	1	0	6	1	7
8/20	7	1	0	1	1	1	0	0	0	0	2	0	11	2	13
8/22	5	0	1	0	0	0	0	0	0	0	3	1	6	4	10
8/26	6	0	1	1	2	3	0	0	0	0	2	0	13	2	15
8/28	2	0	3	5	1	0	0	0	0	0	1	0	11	1	12
8/30	6	0	4	3	0	2	0	2	0	0	0	0	17	0	17
9/1	4	2	0	5	1	4	0	1	0	0	1	0	17	1	18
9/3	3	0	3	3	1	2	0	0	0	0	0	0	12	0	12
9/5	1	0	3	4	2	1	0	0	0	0	1	0	11	1	12
9/7	5	1	1	3	0	3	0	1	0	0	0	0	14	0	14
9/8	6	1	2	2	4	5	0	0	0	0	2	0	20	2	22
9/10	2	2	2	4	0	2	0	1	0	0	1	0	13	1	14
9/12	8	1	2	3	0	0	0	1	0	0	1	0	15	1	16
9/14	3	0	6	3	3	7	0	1	0	0	0	0	23	0	23
9/16	5	3	3	6	5	4	0	2	0	0	0	0	28	0	28
9/17	5	0	1	3	3	6	0	0	0	0	0	0	18	0	18

Appendix G.--Continued.

	Adult			Subadult			Juvenile			Pup			Total		
Date	M	F	U	M	F	U	M	F	U	M	F	U	Non-pup	Pup	Grand
9/18	3	0	4	3	2	5	0	1	0	0	1	0	18	1	19
9/20	4	0	5	6	2	3	0	1	0	0	0	0	21	0	21
9/22	6	0	3	4	2	1	0	2	1	0	0	0	19	0	19
9/24	6	1	4	6	5	4	0	1	0	0	1	0	27	1	28
9/26	6	1	2	4	3	3	0	1	0	0	0	0	20	0	20
9/28	9	0	3	4	5	3	0	0	0	0	0	0	24	0	24
9/30	7	1	3	6	4	7	0	1	0	0	2	0	29	2	31
10/3	8	3	1	5	2	4	0	1	0	0	1	0	24	1	25

Appendix H.--Average number of Hawaiian monk seals, by size and sex, per sector for total of 62 censuses at Kure Atoll, 1987. Whole-atoll counts only (M = male, F = female, and U = unknown).

	Adult			Subadult			Juvenile			Pup			
Sector	M	F	U	M	F	U	M	F	U	M	F	U	Total
Green Island													
Sector 1	0.2	0.1	0.0	0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.7
Sector 2	1.4	0.6	0.6	1.5	1.0	1.4	0.0	0.0	0.0	0.1	0.0	0.0	6.8
Sector 3	0.5	0.2	0.2	0.3	0.4	0.3	0.0	0.0	0.0	0.0	0.0	0.0	1.9
Sector 4	0.5	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.0
Sector 5	0.5	0.1	0.3	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	1.6
Sector 6	0.5	0.1	0.3	0.4	0.1	0.2	0.0	0.2	0.0	0.0	0.1	0.0	1.9
Sector 7	0.3	0.2	0.2	0.2	0.1	0.1	0.0	0.1	0.0	0.0	0.1	0.1	1.3
Sector 8	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.4
Shark Island	0.6	0.1	0.4	0.4	0.4	0.2	0.0	0.1	0.0	0.0	0.0	0.0	2.3
Sand Island	1.8	0.6	0.9	1.3	0.9	1.0	0.0	0.0	0.0	0.1	0.1	0.0	6.7
Stark Island	0.0	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pup enclosure	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	1.3	0.0	2.0
Total	6.5	2.2	3.1	4.8	3.3	3.5	0.0	1.2	0.2	0.3	1.7	0.1	27.0

Appendix I.--Itinerary for the captive maintenance program at Kure Atoll, 1987.

Date	Event
3/25-4/13	Fenced, ocean-beach enclosure is constructed at Kure Atoll for captive maintenance program.
4/14	Hawaiian monk seal yearlings from French Frigate Shoals (ID No. YL14, YL15, and YL16) are flown to Kure Atoll via U.S. Coast Guard C130 and are placed in the ocean-beach enclosure. All yearlings immediately begin eating live fish.
4/15	First Kure-born pup (ID No. KN97) is added to enclosure.
4/20	Heavy surf breaks fencing allowing the escape of YL14, YL16, and KN97. KN97 and YL14 are returned to the enclosure.
4/21	A large subadult male climbs over fencing of enclosure. He is corralled out without incident.
4/23	YL16 is found on Sand Island with a shark bite on chest and is returned to the enclosure. KN88 is weaned early and is added to enclosure.
4/27	Begin medicating YL16 for shark wound; 500 mg ampicillin capsules twice daily.
5/4	Terminate medication for YL16. She is active, and the wound has begun to heal.
5/17	KN90 is born along the back side of the enclosure.
6/22	Release YL16 and YL14.
6/24	Release YL15.
6/27	KN90 is added to the enclosure.
7/4	YL14 is seen with bite marks on flank.
7/6	YL14 is returned to the enclosure. KN90 has abcess on back.
7/7	Healing abcess on KN90 opens.
7/13	YL14 released.
7/14	Begin supplementing diet of KN90 with herring, because of her small size.
8/17	KN90 has gained 11 cm in girth.
8/24	Enclosure is weakening because of poor wire mesh and storms.
8/25	KN88 is flown to Honolulu for winter maintenance. KN90 and KN97 are released.
8/26-9/4	Enclosure is disassembled.
9/4-10/6	YL14, YL15, KN90, and KN97 are resighted often. YL16 has not been resighted since 1 July 1987.

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